(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
25 April 2002 (25.04.2002)

PCT

(10) International Publication Number
WO 02/33731 A2

(51) International Patent Classification[7]: H01K 1/00

(21) International Application Number: PCT/US01/29476

(22) International Filing Date: 19 September 2001 (19.09.2001)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
09/687,371 13 October 2000 (13.10.2000) US

(71) Applicant: GENERAL ELECTRIC COMPANY [US/US]; One River Road, Schenectady, NY 12345 (US).

(72) Inventors: SPIRO, Clifford; 35550 Maplegrove Road, Willoughby Hills, OH 44094 (US). LIESZKOVSZKY, Laszlo, Viktor; Apartment 156, 6809 Mayfield Road, Mayfield Heights, OH 44124 (US).

(74) Agents: HARRINGTON, Mark, F.; Harrington & Smith, LLP, 1809 Black Rock Turnpike, Fairfield, CT 06432-3504 et al. (US).

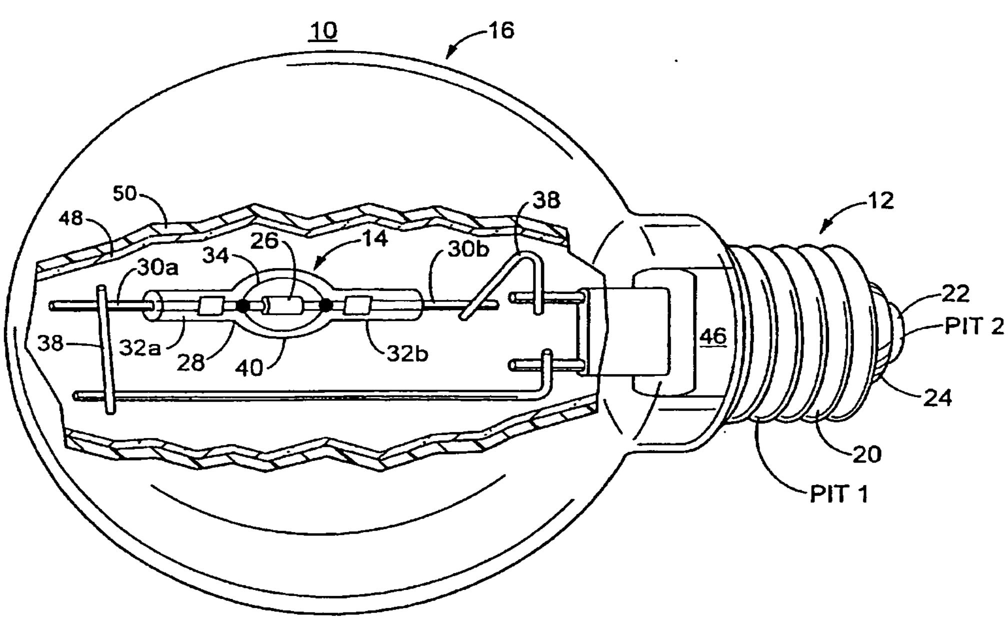
(81) Designated State *(national)*: JP.

(84) Designated States *(regional)*: European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR).

Published:
— *without international search report and to be republished upon receipt of that report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: ENERGY EFFICIENT HOUSEHOLD LIGHT BULB



(57) Abstract: An energy efficient household lamp (10). The lamp includes a base (12) having first and second conductive terminals (PIT1, PIT2). A light source (14) has first and second leads (30a, 30b) that are connected to the first and second terminals of the base. The light source is coated with an interference filter material (40). A translucent outer jacket (16) is connected to the base and surrounds the light source. The translucent outer jacket include is strengthened to prevent a user from coming in contact with the light source.

WO 02/33731 A2

ENERGY EFFICIENT HOUSEHOLD LIGHT BULB

Technical Field

The present invention relates generally to lamps and, in particular, to an energy efficient household bulb.

Background Art

Regular household light bulbs are not always energy efficient solutions for general illumination. Compact fluorescent bulbs are available, but are much more costly and suffer from poor light quality and a low color rendering index. Bulbs with a poor color rendering index do not produce natural looking light.

Lamps that utilize an interference filter to reflect infrared radiation back onto the incandescent filament are known in the prior art. For example, U.S. Patent No. 5,587,626 to Parham et al. discloses a lamp employing an infrared reflecting filter. The '626 patent discloses providing an optical filter material or coating on portions of an arc tube. The portions of the arc tube that are coated with an optical interference filter material reflect selected portions of the emitted radiation back toward the arc discharge filament. A portion of the emitted radiation that is reflected back toward the arc discharge filament is converted to visible light radiation which increases the overall efficiency of the lamp.

The November 1999 issue of Lighting Equipment News disclosed a household general lighting service (GLS) bulb that sealed a linear halogen tube having an infrared coating on its outer surface inside a PS 60 shaped GLS bulb. <u>Who says no-one can make a lamp to the IEA spec? Here's one we knocked up in our lunch-time (well, almost)</u>, Lighting Equipment News, November 1999. The efficiency of the bulb was increased by packaging a transformer in the bulb which lowered the typical voltage applied to the bulb to 12 volts and reduced power consumption to 60 watts. The disclosed GLS household

bulb significantly increases the efficiency of the household bulb. The inner halogen tube of the bulb will continue to operate when the thin outer jacket is broken or ruptures.

U.S. Patent No. 4,112,485 to Sutter discloses a lamp having one or more light sources encapsulated by casting in an inner relatively soft impact absorbing transparent material, such as polymerized silicone rubber, and in an outer relatively hard impact resistant transparent material, such as acrylic or glass.

U.S. Patent No. 3,946,263 to Protzeller discloses an encapsulated lamp for use under submerged conditions and in environments where temperature variations are extreme or corrosive conditions exist. The entire lamp assembly is sprayed, brushed or dipped in a silicone coating to provide a thin film of protective silicone material on the outside of the lamp and on the junction between the leads and the busses.

U.S. Patent No. 5,410,212 to Reisman, assigned to the assignee of the present invention, discloses incandescent reflector lamps of the R and ER type having a light-projecting portion that is coated with silicone containing untreated titanium dioxide particles of relatively coarse size.

U.S. Patent No. 4,463,277 discloses a compact halogen-cycle type incandescent lamp with an envelope of a selected hard glass, borosilicate or aluminosilicate glass for example.

Disclosure of Invention

The present invention concerns an energy efficient household lamp. The lamp includes a base, a light source, and a translucent outer jacket. The base includes first and second conductive terminals. The light source includes a light emitting portion and an envelope that surrounds the light emitting portion. The envelope that surrounds the light emitting portion is coated with an interference filter material for reflecting infrared radiation onto the light emitting portion. The light source includes two leads that are electrically

connected to the first and second conductive terminals of the base. The translucent outer jacket is connected to the base and surrounds the light source. The outer jacket is strengthened to prevent breakage of the outer jacket. The outer jacket may be strengthened by coating it with a protective material, such as rubber or silicone. The outer jacket may also be strengthened by constructing the outer jacket from thick glass. For example, the outer jacket may be over 1mm thick or may be over 3mm thick.

The energy efficient lamp may also include a transformer interposed between the first and second conductive terminals of the base and the leads of the light source. The transformer may convert the voltage supplied to the first and second terminals of the base of the lamp to less than 20 volts supplied to the light source, for example, 12 volts supplied to the light source.

Additional features of the invention will become apparent and a fuller understanding will be obtained by reading the following detailed description in connection with the accompanying drawings.

Brief Description of Drawings

Figure 1 is a perspective view of an energy efficient household bulb coated with a protective material;

Figure 2 is an energy efficient household bulb having a thick glass outer jacket;

Figure 3A is a schematic of an energy efficient household bulb;

Figure 3B is an illustration of a waveform that represents a voltage between a positive bus and a negative bus; and

Figure 3C is an illustration of a waveform that represents a voltage supplied by an inverter.

Best Mode for Carrying Out the Invention

The present invention is directed to a safe, energy efficient household lamp 10. The lamp 10 includes a base 12, a light source 14 and a translucent outer jacket 16.

The base includes first and second conductive power input terminals PIT1, PIT2. The first conductive terminal PIT1 is defined by a threaded portion 20 of the lamp base 12. The second conductive terminal PIT2 is located at an end 22 of the base 12. The first and second conductive power input terminals PIT1, PIT2 are spaced apart by an electrical insulator 24. In the exemplary embodiment, the base 12 of the lamp 10 is sized to be threaded into a standard household lamp socket.

In the exemplary embodiment, the light source 14 includes a light emitting portion 26, an envelope 28 and first and second leads 30a, 30b. Referring to Figures 1 and 2, the envelope 28 is made of a porous material, such as quartz, and includes first and second end portions 32a, 32b and a central elliptical or bulbous portion 34. In the exemplary embodiment, the light emitting portion 26 is a linear light generating filament. The leads 30a, 30b coaxially extend from the end portions 32a, 32b of the light source envelope 28. The endportions 32a, 32b are sealed around the leads 30a, 30b. The light emitting portion 26 is positioned within the bulbous portion 34 of the envelope 28 and is supported at opposite ends by the end portions 32a, 32b of the envelope. The light source 14 is supported by the leads 30a, 30b which are electrically connected and mechanically fastened to wires 38 that support the light source 14 in the translucent outer jacket 16.

In the exemplary embodiment, the light source envelope 28 includes an interference filter coating 40. The interference filter coating 40 reflects infrared radiation emitted by the light emitting portion 26 back onto the light emitting portion 26, while allowing visible radiation to pass through the envelope 28. At least a portion of the infrared radiation that is reflected back onto the light emitting portion 26 is converted into visible light. The infrared radiation reflected back onto the light emitting portion 26 causes the temperature of the light emitting portion 26 to increase. The increase in temperature of the light generating filament causes the intensity of visible light emitted from the light emitting

portion 26 to increase, thereby increasing the efficiency of the lamp 10.

In the exemplary embodiment, the interference filter coating 40 is comprised of alternating layers of high and low index of refraction materials applied to an outer surface of the light source envelope 28. In the exemplary embodiment, the material used to form the envelope 28 is vitreous silica or aluminosilicate hard glass. U.S. Patent No. 5,587,626 to Parham et al., assigned to the assignee of the present invention, discloses providing an interference filter in a predetermined pattern on a lamp envelope and is incorporated herein by reference.

Referring to Figure 3A, a voltage reducing transformer circuit 46 is interposed between the leads 30a, 30b of the light source 14 and the first and second conductive power input terminals PIT1, PIT2 of the lamp 10. The electrical circuit diagram of the exemplary embodiment of this circuit 46 is depicted in Figure 3A. The power input terminals PIT1, PIT2 are connected with the input terminals of a full-waive bridge rectifier arrangement BR, which includes a thermally-activated automatically-resettable cut-out switch COS. An unfiltered DC output voltage from the full-waive bridge rectifier BR is applied to an inverter IM by a positive bus B+ and a negative bus B-. The positive bus B+ is connected to the positive output terminal of the bridge rectifier BR and the negative bus B- is connected to the negative output terminal of the bridge rectifier BR.

The inverter IM includes a pair of capacitors C1, C2. The capacitors are connected in series between the positive bus B+ and the negative bus B-. The junction between the two capacitors C1, C2 is denoted by the reference characters CJ.

A pair of transistors Q1, Q2 are connected in series between the positive bus B+ and the negative bus B- with the collector of the first transistor Q1 being connected to the positive bus B+ and the emitter of the second transistor Q2 being connected to the negative bus B-. The collector of the second transistor Q2 is connected to the emitter of the first transistor Q1 at a junction designated QJ.

A first saturable current transformer CT1 has a primary winding CT1p and a secondary winding CT1s. A second saturable current transformer CT2 has a primary winding CT2p and a secondary winding CT2s. The secondary winding CT1s of current transformer

CT1 is connected directly between the base and the emitter of the transistor Q1. The secondary winding CT2s of the current transformer CT2 is connected directly between the base and emitter of the transistor Q2. Primary windings CT1p and CT2p are connected in series directly between junction QJ and a point designated X on Figure 3A.

A high frequency transformer HFT, includes a primary winding HFTp connected between junction CJ and point X. The secondary winding HFTs of the high frequency transformer HFT is connected to the light source 14. A first lead of a resistor R1 is connected to the positive bus B+ and a second lead of the resistor R1 is connected to a first lead of a second resistor R2. The second lead of the resistor R2 is connected to a junction DJ. It should be readily apparent to those skilled in the art that resistors R1, R2 can be replaced with a single resistor. A first lead of capacitor C3 is also connected to junction DJ. The second lead of capacitor C3 is connected to the negative bus B-. A diac D is connected between junction DJ and the base of the transistor Q2. An anode of rectifier R is connected to junction DJ and a cathode of rectifier R is connected to the point designated X.

In the exemplary embodiment, an ordinary 120 volt/60Hz power voltage is applied between the power input terminals PIT1, PIT2. The voltage is full wave rectified by the bridge rectifier BR. In the absence of filtering, the voltage provided at the output of the bridge rectifier BR is depicted in Figure 3B. The voltage depicted in Figure 3B is applied directly between the positive bus B+ and the negative bus B- of the inverter IM. The inverter IM, which consist of two transistors Q1, Q2 connected in series in combination with the two positive feedback current transformers CT1, CT2 represents a self-oscillating half bridge inverter and operates in a manner that is analogous with circuits previously described in U.S. Patent No. 4,184,128 to Nilssen. Since the DC voltage-supply feeding the inverter IM has no filtering capacitors, it is necessary to provide within the inverter, a lower impedance return path for the inverter current. Such a low impedance return path is provided by way of the two series-connected capacitors C1, C2. However, it is necessary that the capacitance values of these capacitors be kept small enough not to represent significant energy-storing capacity in comparison to the amount of energy being drawn by the invertor over a half cycle of the power line voltage. In the exemplary embodiment, with the power drawn being approximately 40 watts the

energy stored by two series-connected 47µf capacitors is small in comparison to the overall power drawn.

Again referring to Figure 3A, the bases of the transistors, in terms of DC, are shorted to their emitters through the secondary windings of current transformers CT1 and CT2. By implication, the inverter cannot start oscillating by itself. However, by providing a single brief pulse to the base of transistor Q2, the transistor is caused to conduct momentarily. The pulse required to trigger the inverter is supplied by diac D. The diac is triggered by the voltage supplied by capacitor C3. The momentary conduction causes transistor Q2 to conduct. The momentary conduction is enough to cause the inverter to oscillate, provided that there is adequate voltage between the negative bus B- and the positive bus B+. Once in oscillation, the inverter will continue to oscillate until the voltage between the negative bus B- and the positive bus B+ falls to a level low enough as to be inadequate for sustaining generative feedback.

Referring to Figure 3C, the output of the half bridge inverter circuit is substantially squarewave at a frequency of 30Khz. The output of the half bridge inverter is provided between point X and junction CJ, to which the primary winding of the high frequency transformer HFT is connected. The peak-to-peak amplitude of the squarewave voltage is equal to the magnitude of the DC voltage present between the negative bus B- and the positive bus B+. The light source 14 is connected directly across the secondary winding of transformer HFT, thereby communicating the voltage provided by the voltage reducing transformer HFT to the light source 14. The voltage applied to the light source 14 is equal to the voltage provided at the output X, CJ of the half bridge multiplied by the ratio of the number of secondary winding turns on the high frequency transformer to the number of primary winding turns on the high frequency transformer.

Since the inverter circuit IM is supplied with a pulse DC voltage, as indicated in Figure 3B, if the inverter circuit is oscillating at a given time, it will cease to oscillate when the DC supply voltage falls below a certain minimal level V2 shown in Figure 3B. If the inverter is triggered into oscillation at some time during each of the unidirectional sinusoidal shaped voltage pulses constituting the DC supply voltage, it will cease to oscillate at or near the end of each of these pulses. The inverter circuit can be triggered

on, and will remain on until the end of a power cycle until current flowing to the light source 14 falls below a certain minimal level. The inverter circuit can be triggered at substantially any point within the power cycle allowing it to be phase controlled. The RMS power provided to the light source 14 can be controlled over a wide range by controlling the timing of the inverter trigger point (T1 in Figure 3B).

In Figure 3A, resistors R1, R2 in combination constitute a resistance means through which capacitor C3 is charged. By adjusting the resistance provided by resistors R1, R2, the time to charge capacitor C3 is similarly adjusted. The phase-out point at which the converter is triggered into oscillation is correspondingly adjusted. The circuit can be adjusted by adjusting the values of resistors R1, R2 to provide an output voltage to the light source 14 ranging in magnitude from 12 to 24 volts. In one embodiment the voltage supplied to the light source 14 is 15 volts RMS. The actual optimum design voltage depends on power level and construction details of the light source 14. One example of a circuit used to reduce the voltage supplied to the light source 14 in accordance with the present invention is disclosed in U.S. Patent No. 4,998,044 to Nilssen, which is incorporated herein by reference. It should be apparent to those skilled in the art that any one of many circuits may be used to reduce the voltage applied to the light source 14.

Referring to Figures 1 and 2, the translucent outer jackets 16 is disposed around the light source 14. For purposes of this patent application, the term "translucent" means allowing all or a portion of light to pass through. Since the light source 14 is self-contained, it would continue to operate if the translucent outer jacket of the lamp were broken. For purposes of this patent application, the term "translucent" means allowing all or a portion of light to pass through. The reduce the chance of allowing a consumer to come in contact with the light source when the translucent outer jacket 16 is broken, the translucent outer jacket is strengthened in the exemplary embodiment.

Referring to Figure 1, in a first embodiment the translucent outer jacket 16 includes an inner glass layer 48 coated with a transparent or translucent silicone coating 50. The silicone coating 50 strengthens the translucent outer jacket 16. In the exemplary embodiment, the inner glass layer 48 is a standard A-19 soda-lime glass envelope. The silicone coating 50 is provided on the inner glass layer 48 with a thickness of 5 to 20 mil.

The light transmission of the silicone coating 50 exceeds 85%. The material of the silicone coating 50 is silicone rubber, withstanding the operating temperature of the translucent outer jacket 16, which is typically in the range of 140°C to 230°C, depending on the wattage of the filament tube. The coating may be applied to the inner glass layer 48 by dip coating, spraying or molding. In the exemplary embodiment, the lamp 10 is dipped into a silicone solution. The lamp 10 is then dried for 3 minutes. The solvent is evaporated from the lamp 10 for 24 hours by placing the lamp 10 in a furnace (not shown) operated between 45°C and 80°C. Several layers of coating can be applied to the lamp 10 to achieve desired thickness of coating depending on the viscosity of the solution into which the lamp 10 is dipped. In the exemplary embodiment, the range of thickness of silicone coating 50 is between 2 and 15 mil. The coating undergoes a final curing in a furnace operated at a temperature of 120°C to 200°C for 2 to 15 minutes to achieve maximum strength. In the exemplary embodiment, GE silicones UltraTufel 96505U methyl silicone rubber is used to coat the inner glass layer of the lamp 10. The coating reduces the risk of fire and injury to the user of the bulb, because the user of the bulb cannot access the light source 14 of the lamp 10 in the event the inner glass layer 48 breaks.

In the embodiment shown in Figure 2, the silicone rubber coated outer jacket is replaced with a thick glass envelope 51 having a thickness 52 greater than 1mm thick. In the exemplary embodiment, the thickness 52 is 3mm. The thick glass envelope 51 may be clear, etched, frosted, colored or E-coated. In the event that the light source 14 were to explode, the thick outer jacket 51 reduces the likelihood of the translucent outer jacket 16 of breaking. In addition, the strength of the thick glass envelope 51 is such that if the thick glass envelope 51 were to be broken by shock or impact, the light source 14 would also be broken, eliminating the chance that a user could access a hot light source. Examples of thick glass envelopes that can be used in accordance with the present invention are GE part number 60A/HAL, product code 45266; Ge part number 75A/HAL, product code 45259; and GE part number 90A/HAL, product code 45648.

An energy efficient household bulb constructed in accordance with the present invention improves the energy efficiency of the bulb by 10% - 50% and increases the useful life of

the bulb by a factor of 2 - 5. At the same time, the energy efficient bulb is safe, because a user of the lamp 10 is inhibited from accessing the light source 14 in the event that the translucent outer jacket 16 is broken.

Although the present invention has been described a degree of particularity, it is the intent that the invention include all modifications and alterations falling within the spirit and scope of the appended claims.

CLAIMS

We claim:

1. A lamp 10 comprising:

a) a base 12 having first and second conductive terminals PIT1, PIT2,

b) a light source 14 including a light emitting portion 26 and an envelope 28 that surrounds said light emitting portion, said envelope being coated with interference filter material 40 for reflecting infrared radiation onto said light emitting portion, said light source including first and second leads 30a, 30b electrically connected to said first and second conductive terminals; and

c) a translucent outer jacket 16 connected to said base and disposed around said light source, said outer jacket including a protective layer 50 to strengthen the outer jacket.

2. The lamp of claim 1 wherein said protective material is rubber.

3. The lamp of claim 1 wherein said protective material is silicone.

4. The lamp of claim 1 further comprising a voltage transformer 46 interposed between said first and second conductive terminals and said first and second leads.

5. The lamp of claim 4 wherein said voltage transformer reduces a first voltage supplied to said first and second terminals to a lower voltage of less than 24 volts supplied to energize said light source.

6. The lamp of claim 4 wherein said voltage conversion means converts the first voltage supplied to said first and second terminals to about 12 volts supplied to said light source.

7. A lamp 10 comprising:

a) a base 12 having first and second conductive terminals PIT1, PIT2,

b) a light source 14 including a light emitting portion 26 and an envelope 28 that surrounds said light emitting portion, said envelope being coated with interference filter material 40 for reflecting infrared radiation onto said light emitting portion, said light source including first and second leads 30a, 30b electrically connected to said first and second conductive terminals; and

c) a translucent outer jacket 16 connected to said base and disposed around said light source, said jacket being at least 1 millimeter thick.

8. The lamp of claim 7 wherein said protective material is at least 3 millimeters thick.

9. The lamp of claim 7 further comprising a transformer 46 interposed between said first and second conductive terminals and said first and second leads.

10. The lamp of claim 9 wherein said transformer converts a first voltage supplied to said first and second terminals to less than 24 volts supplied to said light source.

11. The lamp of claim 9 wherein said voltage conversion means converts a first

voltage supplied to said first and second terminals to 12 volts supplied to said light source.

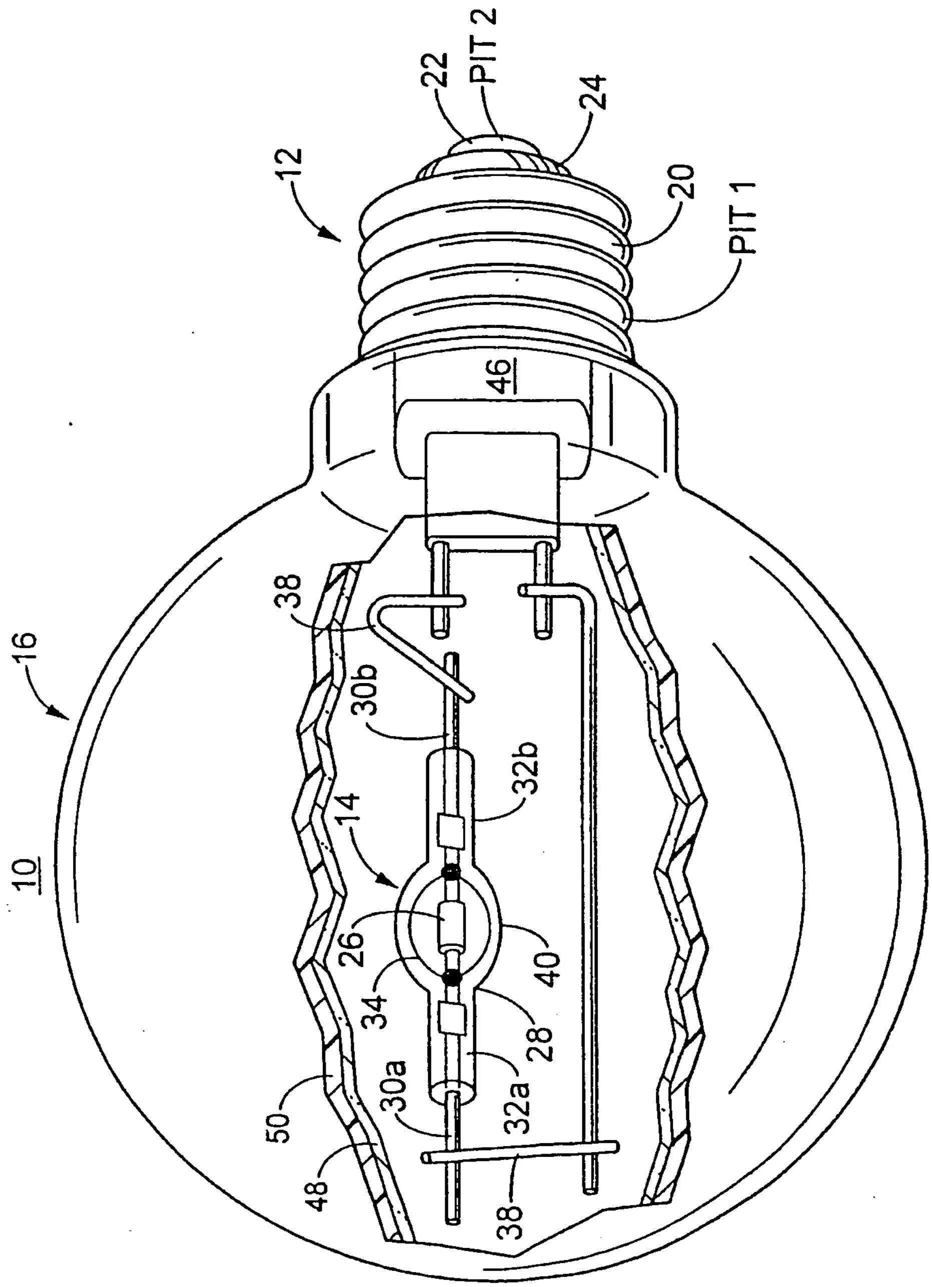

10
16
12
22
PIT 2
24
20
PIT 1
46
38
30b
32b
14
26
40
34
28
30a
32a
50
48
38

FIG. 1

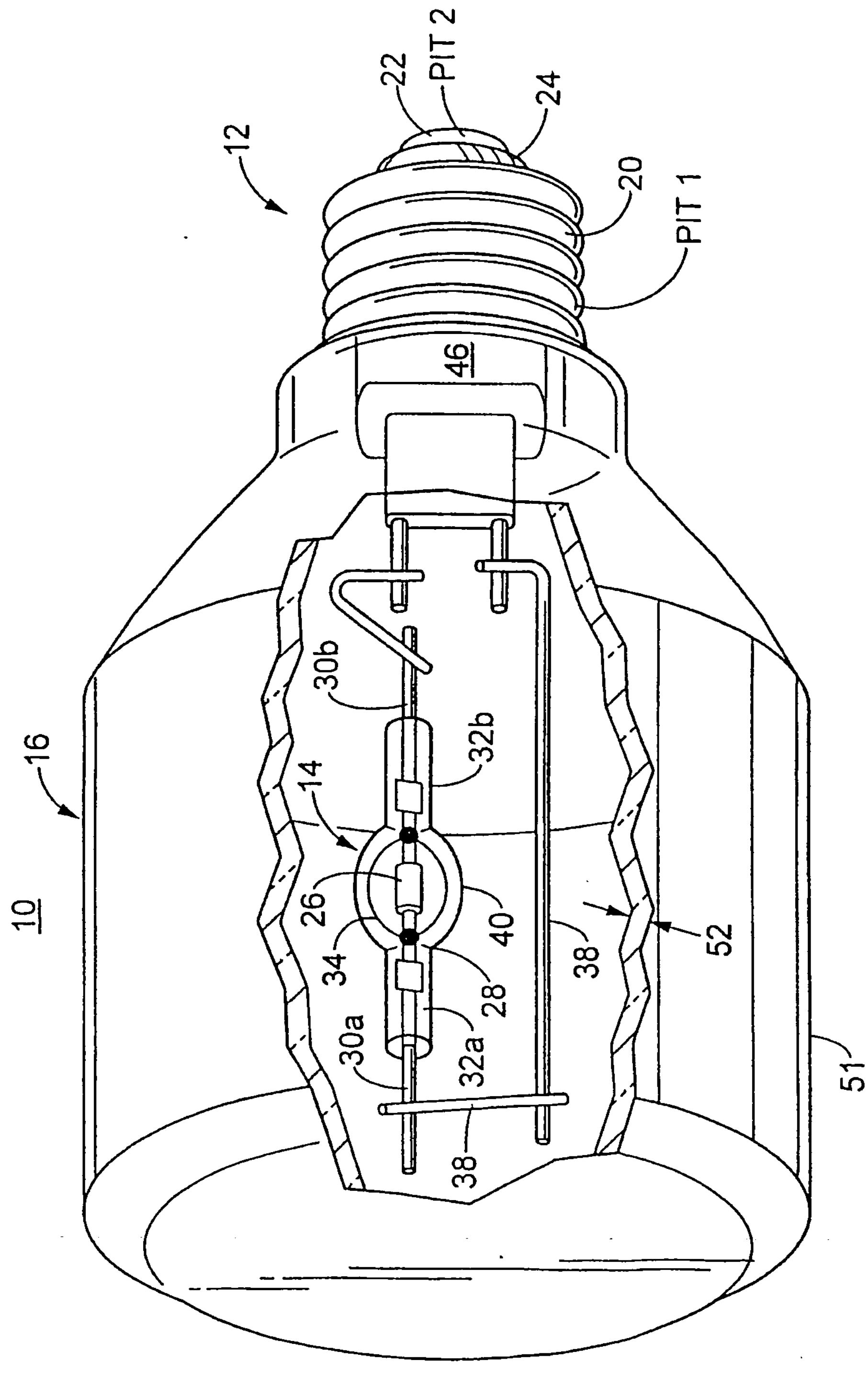

12
22
PIT 2
24
20
PIT 1
46
16
10
30b
32b
14
26
40
34
28
38
52
30a
32a
38
51
38

FIG. 2

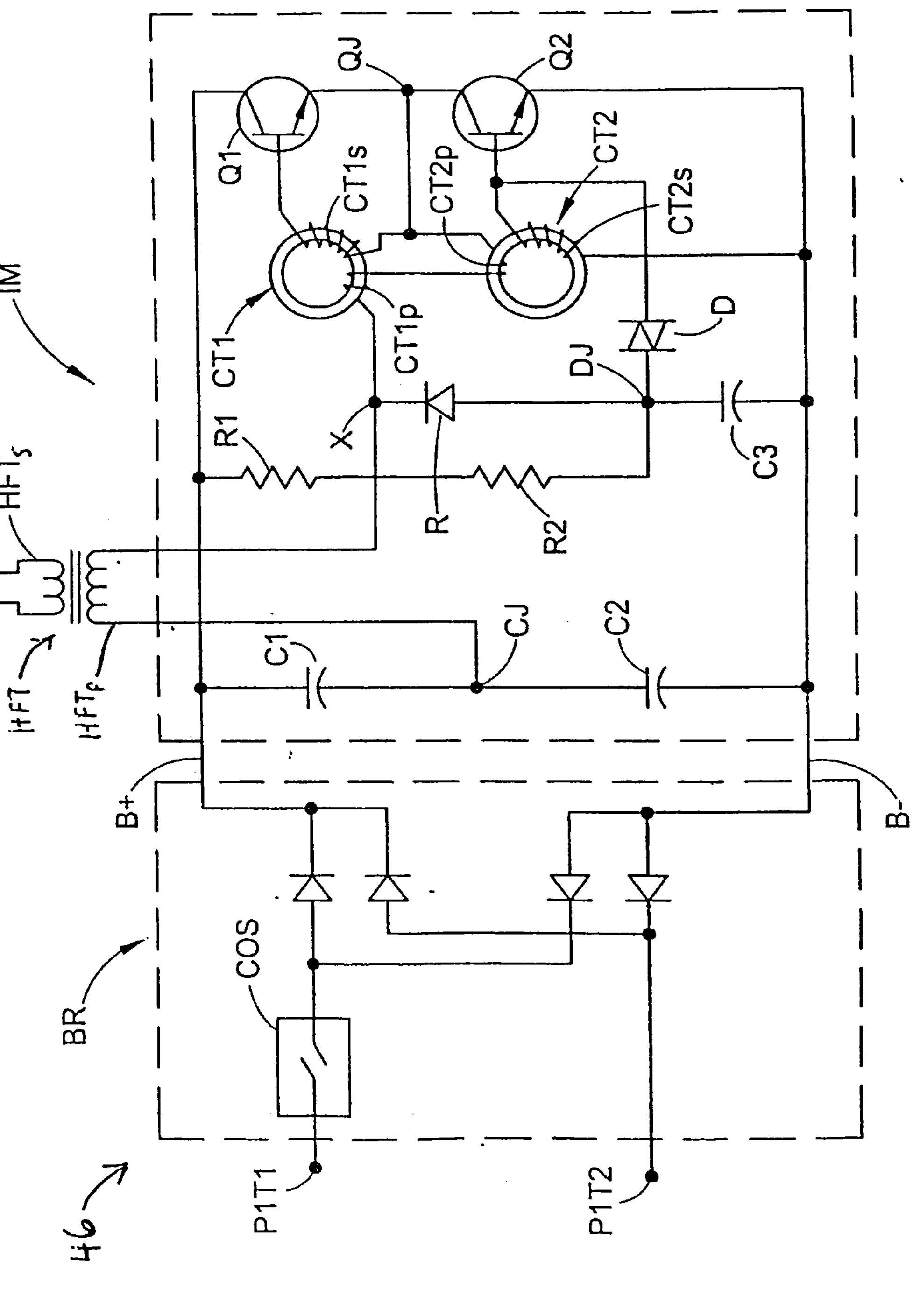

IM
QJ
Q1
Q2
CT1s
CT2p
CT2
CT2s
CT1
CT1p
D
DJ
X
R1
R
R2
C3
26
14
30b
30a
HFT$_S$
HFT
HFT$_P$
C1
CJ
C2
B+
B-
BR
COS
P1T1
P1T2
46

FIG. 3a

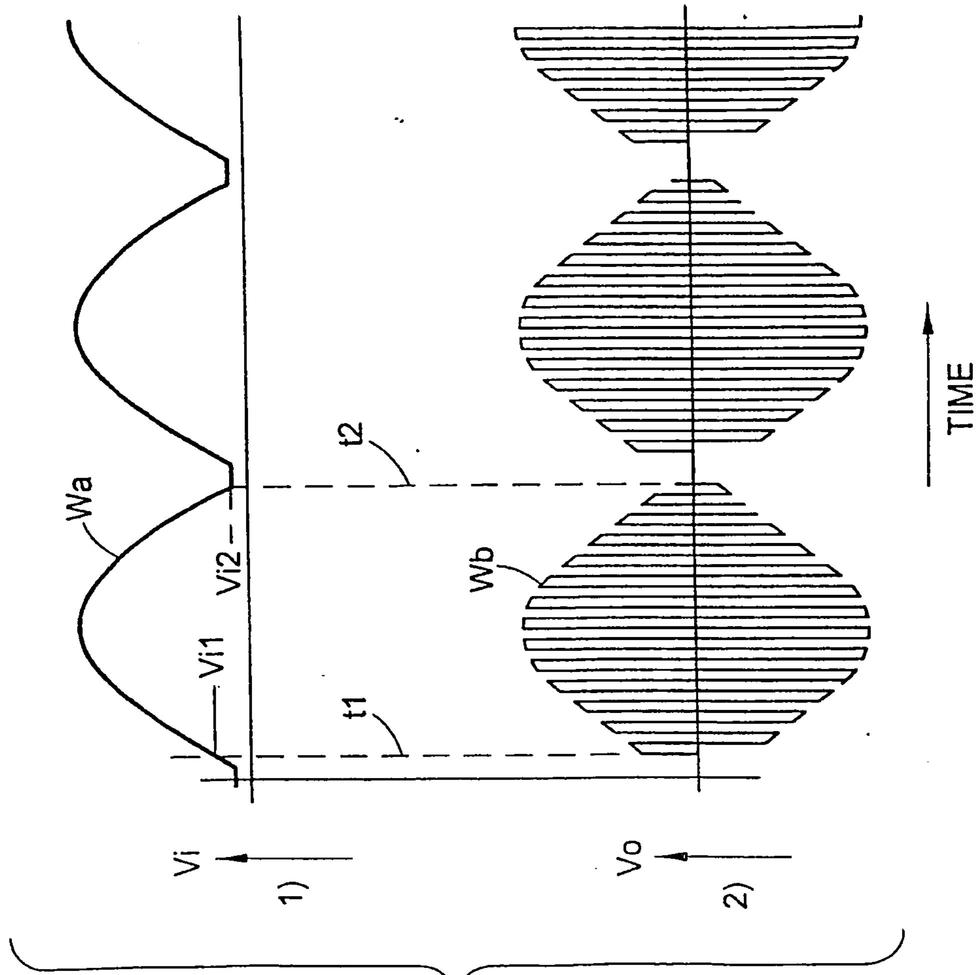


FIG. 3b